Proceedings of the American Academy of Arts and Sciences.

VOL. XLIV. No. 17.—APRIL, 1909.

CONTRIBUTIONS FROM THE HARVARD MINERALOGICAL MUSEUM.—XIII.

NOTES ON THE CRYSTALLOGRAPHY OF LEADHILLITE.

I. *LEADHILLITE FROM UTAH.*

BY C. PALACHE AND L. LA FORGE.

II. *LEADHILLITE FROM NEVADA.*

BY C. PALACHE.

WITH THREE PLATES.

CONTRIBUTIONS FROM THE HARVARD MINERALOGICAL MUSEUM. — XIII.

NOTES ON THE CRYSTALLOGRAPHY OF LEADHILLITE.

BY C. PALACHE AND L. LA FORGE.

I. LEADHILLITE FROM UTAH.

Presented December 9, 1908. Received January 14, 1909.

THE crystals of leadhillite described in this paper were found and sent to the Harvard Mineralogical Museum for identification and study by A. F. Holden, then of Salt Lake City, in 1897. The writers desire to express here their thanks to Mr. Holden for so generously placing this rare material in their hands for investigation.

The leadhillite was found in the Eureka Hill Mine, Tintic Mining District, Utah, at a depth of 500 feet. It occurred in a few cavities in massive galena which are coated with quartz and anglesite, upon which the leadhillite is implanted. Of its occurrence Mr. Holden writes that it seems to appear only where the galena is impure, anglesite being the sole alteration product where the galena is free from impurities. The anglesite is both massive and in small clear colorless crystals, elongated parallel to the *b* axis and showing the forms c (001), b (010), m (110), l (104), o (011), and y (122), the latter form dominant.

So far as known to us the material sent us is all that was found.[1] It consists of several loose crystals of rhombohedral appearance and dull lustre, semitransparent, and of several pieces of massive galena with leadhillite crystals still attached to the walls. The latter crystals are transparent, of a faintly yellowish white color and adamantine lustre. They are mostly tabular, half an inch or less across, and upwards of an eighth of an inch thick. The most prominent characteristic by which they may certainly be distinguished from the accompanying

---

[1] In "Utah Minerals and Localities," Maynard Bixby, Salt Lake City, 1904, the occurrence of leadhillite in the Tintic District is described as follows: "Leadhillite has been observed rarely, but the crystals seen were of good quality, nearly colorless, and averaged possibly more than a half inch across." This is the only published reference to this occurrence.

anglesite is the highly perfect basal cleavage parallel to which the lustre is pearly. The crystals detached for measurement are with one exception minute fragments removed from aggregates or larger crystals; the cleavage develops so readily that it is exceedingly difficult to remove a crystal entire. These fragments are in nearly all cases, therefore, bounded by cleavage above and below, with edges more or less completely faceted with faces of pyramids, domes, and prisms. Their complex character may be judged by one crystal (Table II, No. 14, p. 439), a fragment about 2 mm. in diameter, on which were measured seventy faces belonging to thirty-five forms. On this crystal and some others, faces of both positive and negative forms occur on the upper end of the crystal; in others the forms are clustered about the end of the *a* axis, so that the positive forms are on the upper part and negative ones on the lower part, requiring two adjustments on the goniometer for measurement. With added complications due to twinning, described in another place, the adjustment of the crystals, their orientation, and the interpretation of the forms, were problems of some difficulty, which could hardly have been solved without the use of the two-circle goniometer and of the graphical method in gnomonic projection. The method followed was generally as follows. The basal cleavage, always present, is so nearly in polar position ($\beta = 89° 30'$), that an approximate adjustment was made by its means. The prism zone was then sought by turning the horizontal circle of the goniometer 90° from polar position, and this zone if present gave a final adjustment. In some cases it was necessary to make a rough determination of some of the forms with the first approximate adjustment by the base, and then to readjust to the calculated angles of these forms, a somewhat laborious but entirely accurate process.

Once adjusted, the clinodome zone could generally be recognized by its striated character, but in general no attempt to identify the forms was made until a projection had been constructed from the measurements. Here the principal zones at once appeared, and the positive and negative forms could be separated and forms in twin position sifted out. Cases were very rare where by these means the orientation of the crystal could not be made with entire certainty.

Some twenty crystals were measured, and of these fifteen yielded measurements that could be used in the computation of the elements. Sixty-three forms were observed, as shown in Table I, in which is given for each the computed angles ϕ and ρ, the arithmetic mean of the observed values of ϕ and ρ, the deviation in minutes of the extreme observations for each from the computed value, and the number and quality of the observations.

TABLE I.

Letter.	Symbol — Gdt.	Symbol — Miller.	No. Times.	Computed. φ	Computed. ρ	Measured. φ	Measured. ρ	Variation. φ +	Variation. φ −	Variation. ρ +	Variation. ρ −	Average Quality.	Occurs in Twinned Position.
				° ′	° ′	° ′	° ′	′	′	′	′		
c	0	001	39	90 00	0 30	. . .	0 26	. .	. .	29	27	good	comm'ly
a	$\infty 0$	100	9	90 00	90 00	90 00	90 00	. .	. .	. .	. .	good	
b	0∞	010	9	0 00	90 00	. . .	. . .	. .	. .	. .	. .	poor	
d	2∞	210	10	66 23	90 00	66 16	. . .	2	26	. .	. .	fair	once
l	∞	110	8	48 50	90 00	48 49	. . .	7	9	. .	. .	fair	once
L	$\frac{2}{3}\infty$	230	9	37 20	90 00	37 20	. . .	8	7	. .	. .	fair	twice
m	$\infty 2$	120	17	29 46	90 00	29 48	. . .	48	12	. .	. .	fair	
ν[1]	$0\frac{1}{4}$	014	6	1 46	15 33	1 09	15 21	. .	48	60	90	bad	no
χ[1]	$0\frac{1}{3}$	013	5[2]	1 20	20 21	0 54	19 46	. .	36	9	60	bad	no
α	$0\frac{1}{2}$	012	10	0 53	29 05	0 44	29 14	13	24	50	6	fair	once
η[1]	$0\frac{2}{3}$	023	2	0 40	36 33	0 43	36 42	4	. .	22	3	good	no
Γ[1]	$0\frac{3}{4}$	034	3[2]	0 35	39 50	0 34	39 15	. .	2	36	75	bad	once
[1]	$0\frac{5}{6}$	056	1[2]	0 32	42 50	0 09	43 42	. .	23	52	. .	poor	no
g	01	011	7	0 27	48 02	0 21	48 02	. .	12	24	16	good	twice
h	$0\frac{3}{2}$	032	4	0 18	59 04	0 13	59 24	. .	5	43	4	fair	twice
π[1]	$0\frac{5}{3}$	053	1	0 16	61 39	0 23	61 38	7	. .	. .	1	good	no
φ[1]	02	021	9	0 13	65 48	0 23	65 54	45	13	46	12	fair	once
Λ[1]	03	031	1	0 09	73 19	1 32	73 13	83	. .	. .	6	good	no
ψ[1]	$0\frac{5}{2}$	052	2	0 11	70 13	0 10	70 01	. .	1	. .	25	fair	no
y	40	401	7	90 00	78 54	90 00	79 07	. .	. .	39	6	poor	no
u	20	201	9	"	68 37	"	68 41	. .	. .	20	3	fair	once
z	$\frac{3}{2}0$	302	1	"	62 27	"	61 37	. .	. .	. .	50	bad	no
w	10	101	9	"	52 01	"	52 12	. .	. .	12	48	poor	no
[1]	$\frac{3}{4}0$	304	1[2]	"	43 55	"	44 34	. .	. .	39	. .	fair	no
i	$\frac{2}{3}0$	203	2	"	40 35	"	40 09	. .	. .	. .	47	poor	no
D	$\frac{1}{2}0$	$\bar{1}02$	1	"	32 48	"	31 30	. .	. .	. .	78	poor	once
Δ[1]	$-\frac{1}{2}0$	$\bar{1}02$	1[2]	−90 00	32 06	"	31 57	. .	. .	. .	9	bad	no
E[1]	$-\frac{2}{3}0$	$\bar{2}03$	5	"	40 01	"	40 13	. .	. .	44	5	fair	once
f	−10	$\bar{1}01$	3	"	51 39	"	51 35	. .	. .	38	22	poor	no
e	−20	$\bar{2}01$	9	"	68 29	"	68 32	. .	. .	30	9	good	no
k	1	111	7	49 02	59 29	48 56	59 19	32	29	1	33	fine	twice
s	$1\frac{1}{2}$	212	11	66 32	54 23	66 24	54 15	. .	23	0	42	fine	twice
θ	$1\frac{3}{2}$	232	6	37 31	64 34	37 23	64 34	37	44	21	14	fine	once
x	12	$\bar{1}21$	14	29 56	68 43	29 49	68 34	10	40	14	39	fair	twice
q	$-1\frac{1}{2}$	$\bar{2}12$	10	−66 15	54 05	−66 22	54 08	10	14	50	10	good	twice
p	−1	$\bar{1}11$	15	−48 39	59 17	−48 43	59 20	12	7	51	8	fine	twice
o	$-1\frac{3}{2}$	$\bar{2}32$	8	−37 09	64 28	−37 04	64 46	9	4	64	27	fair	twice
r	−12	$\bar{1}21$	14	−29 36	68 39	−29 39	68 50	12	4	46	7	good	no
A[1]	$-1\frac{5}{2}$	$\bar{2}52$	6	−24 26	71 52	−24 43	71 48	43	2	23	30	good	once
G[1]	−13	131	1	−20 45	74 21	−20 49	74 19	4	. .	. .	2	good	no
ζ	21	$\bar{2}11$	4	66 28	70 15	66 24	69 43	. .	5	32	43	poor	comm'ly
ρ	$-2\frac{1}{2}$	412	6	−77 38	68 55	−77 42	68 53	20	8	16	22	fair	no

[1] New forms. [2] Forms needing confirmation.

TABLE I. — *Continued.*

Letter.	Symbol — Gdt.	Symbol — Miller.	No. Times.	Computed.		Measured.		Variation.				Average Quality.	Occurs in Twinned Position.
				ϕ	ρ	ϕ	ρ	ϕ		ρ			
								+	−	+	−		
				° ′	° ′	° ′	° ′	′	′	′	′		
Y[1]	-21	$\bar{2}11$	2	−66 19	70 09	−66 13	70 41	6	18	66	..	poor	no
W[1]	$-2\frac{3}{2}$	$\bar{4}32$	2[2]	−56 40	71 46	−56 33	71 28	2	2	32	32	bad	no
M[1]	$-2\frac{5}{2}$	$\bar{4}52$	1	−42 22	75 07	−42 01	75 21	..	21	14	..	fair	no
R[1]	-24	$\bar{2}41$	12	−29 41	78 57	−29 48	78 59	52	23	51	36	fair	once
J[1]	$\frac{1}{3}$	113	5	49 24	29 40	49 16	29 39	0	25	43	46	good	no
β	$\frac{1}{3}\ \frac{2}{3}$	$\bar{1}23$	4	30 16	40 39	29 34	40 22	..	64	1	38	fair	no
B[1]	$-\frac{1}{3}\ \frac{2}{3}$	$\bar{1}23$	2	−29 16	40 22	−30 21	39 01	65	..	..	81	good	no
λ	$-\frac{1}{3}\ \frac{1}{6}$	$\bar{2}16$	8	−65 57	24 28	−66 05	24 32	25	..	10	1	good	twice
δ	$\frac{1}{2}\ \frac{1}{4}$	214	6	66 40	35 04	66 19	34 51	..	31	2	40	poor	twice
	$\frac{1}{2}$	112	4	49 13	40 25	48 55	40 20	11	49	1	33	fine	once
t	$\frac{1}{2}1$	122	8	30 06	52 07	29 45	52 36	..	54	52	..	poor	no
N[1]	$\frac{1}{2}\ \frac{5}{8}$	$\bar{4}58$	3	24 53	56 52	24 46	56 44	..	11	1	14	poor	once
μ	$-\frac{1}{2}\ \frac{1}{4}$	$\bar{2}14$	21	−66 06	34 28	−66 05	34 26	30	54	11	13	good	twice
P[1]	$-\frac{1}{2}$	$\bar{1}12$	2	−48 27	39 59	−48 32	40 05	8	..	8	..	fine	no
Q[1]	$-\frac{1}{2}\ \frac{3}{4}$	$\bar{2}34$	20	−36 57	46 14	−36 53	46 17	49	38	38	32	good	thrice
v	$-\frac{1}{2}1$	$\bar{1}22$	11	−29 26	51 56	−29 37	51 46	77	15	29	44	good	twice
T[1]	$-\frac{1}{2}\ \frac{5}{4}$	$\bar{2}54$	2	−24 18	56 45	−24 27	56 45	9	..	3	3	good	once
σ	$-\frac{2}{3}1$	$\bar{2}33$	1	−37 03	54 20	−37 15	54 22	12	..	2	..	fine	no
U[1]	$\frac{1}{3}\ \frac{1}{2}$	$\bar{2}36$	3	37 53	35 10	37 32	34 42	..	21	31	32	bad	once
[1]	$-1\frac{1}{4}$	414	3[2]	−77 35	52 18	−77 10	52 03	..	40	..	77	bad	no
H[1]	2	221	4[2]	48 56	73 33	48 52	73 04	..	4	..	90	poor	once

[1] New forms. [2] Forms needing confirmation.

Of the observed forms thirty-six were previously known and twenty-seven are new, seventeen of these being well established and ten requiring confirmation. But five of the forms previously known for the mineral were not present, namely, F, n, ω, γ, and τ.

The combinations observed are shown in Table II. The prevailing habit is strikingly hexagonal and of two types; (1) tabular, with hexagonal outline (Figures 2 and 3), the prism angle m $\wedge$ m being 120° 28′; (2) rhombohedral through the combination of a positive orthodome with a negative pyramid of about the same inclination to the vertical, there being three groups of forms that produce this effect, namely, w (101) with v ($\bar{1}22$); u (201) with r ($\bar{1}21$); and y (401) with R ($\bar{2}41$). Figures 1 and 9 show the first pair of forms in pseudo-rhombohedral combination. The apparent rhombohedral character is enhanced by the fact that the angle β is very nearly 90°, so that the basal pinacoid,

TABLE II.

UTAH LEADHILLITE.

Crystal No.	c	a	b	d	l	L	m	ν	χ	α	η	Γ	$0\frac{5}{8}$	g	h	π	φ	ψ	y	u	z	w	$\frac{3}{4}0$	i	D	Δ	E	f	e	k	s	θ
1	×	×	×	×	×	×	×				×	×		×		×			×	×		×							×	×	×	
2 Fig. 3	×	×	×				×							×			×	×	×	×									×			
2a " 4	×		×	×		×	×																						×			
3	×	×					×				×	×								×							×		×			
4	×																			×		×								×	×	×
5 Fig. 5	×		×					×	×	×							×															
6	×	×		×	×	×	×	×	×	×		×		×			×		×	×		×						×	×		×	
7 Fig. 6	×	×					×	×		×				×													×		×			
8 Fig. 8	×	×		×	×		×	×		×			×				×		×	×		×								×	×	×
9	×		×				×		×					×	×		×		×	×		×					×	×	×	×	×	
10 Fig. 2	×	×																		×		×				×			×			
11	×	×	×	×	×	×	×													×							×		×	×	×	×
12 Fig. 7	×		×	×	×		×	×		×				×	×		×															
13	×		×	×	×	×	×			×									×	×	×	×		×						×	×	×
14	×	×	×	×	×	×	×			×			×	×			×	×	×			×	×	×			×			×	×	×
15	×	×		×	×		×		×	×			×			×			×	×		×		×	×						×	

Crystal No.	x	ι	p	o	r	A	G	ς	ρ	Y	W	M	R	J	β	B	λ	δ	ϵ	t	N	μ	P	Q	v	T	σ	U	$-1\frac{1}{4}$	H
1	×	×		×	×	×		×					×					×		×				×	×					
2 Fig. 3	×		×	×	×								×									×		×	×					
2a " 4		×	×		×	×							×									×		×	×		×			
3		×	×	×	×				×					×		×		×				×		×						
4	×													×				×												
5 Fig. 5	×		×														×					×		×	×					
6	×	×	×	×	×				×		×		×				×					×		×	×				×	
7 Fig. 6			×		×					×		×					×					×	×	×						
8 Fig. 8	×				×			×					×	×	×			×		×	×	×		×	×	×		×		×
9	×		×		×									×	×			×	×	×					×					
10 Fig. 2		×																				×		×	×					
11	×	×	×	×	×	×		×	×				×									×		×						
12 Fig. 7		×	×		×	×	×	×	×	×	×		×				×					×		×	×	×		×	×	
13	×			×	×	×							×	×	×			×	×	×				×						×
14	×	×	×	×	×					×			×	×	×		×			×	×	×		×	×					
15		×			×				×	×			×		×					×										

generally present as face or cleavage, truncates the summit of the pseudo-rhombohedron with entire symmetry. As before stated, most of the crystals measured were but fragments, and the table of combinations does not therefore give an entirely correct idea of the relative frequency of occurrence of the various forms.

The forms c, a, m, u, and r are present on nearly every crystal. Of

the new forms Q alone is conspicuous by its frequent occurrence. b, d, l, w, e, s, x, q, p, R (a new form), μ, and v are also of frequent occurrence, being found on from one half to two thirds of the measured crystals. The remaining forms are of minor importance, many of them found on but one or two crystals.

The new forms are established upon the following data:

E, $-\frac{2}{3}0$ ($\bar{2}03$). A narrow but distinct face in the orthodome zone on five crystals, giving fair reflections (Figure 6).

	ϕ	ρ	
Crystal 3	$-90°$ 00′	39° 58′	fair.
" 7	-90 00	40 13	poor.
" 9	-89 05	40 45	fine.
" 11	-90 00	40 00	poor.
" 14	-89 42	40 40	good (in twin position).
Calculated	-90 00	40 01	

Clinodome Zone. — This zone is usually largely developed and is apt to be deeply and closely striated parallel to the zonal axis, often with a curved surface. The reflection of the signal from these curved surfaces is a band of light with occasional brighter portions and numerous more or less distinct images of the signal. Most of the latter are in positions corresponding to simple symbols, but only in the cases of those images which were also observed as given by distinct faces has the form been accepted as confirmed.

ν, $0\frac{1}{4}$ (014). Observed repeatedly as a signal in the striated clinodome zone, twice found as a distinct face (Figures 5 and 6).

	ϕ	ρ	
Crystal 5	1° 11′	14° 00′	
" 6	1 04	15 45	
" 7	1 17	15 42	perfect.
" 7	0 53	16 45	poor (in twin position).
" 8	0 00	15 00	
" 8	0 00	17 45	
" 12	1 04	16 21	
" 13	1 10	15 09	
" 13	0 58	15 56	
Calculated	1 46	15 33	

η, $0\frac{2}{3}$ (023).

	ϕ	ρ	
Crystal 1	0° 45′	36° 30′	poor.
" 3	0 41	36 55	good.
Calculated	0 40	36 33	

π, 0$\frac{5}{3}$ (053).

	ϕ	ρ	
Crystal 1	0° 23′	61° 38′	good.
" 15	1 33	61 54	poor.
" 16	0 46	60 34	fair.
Calculated	0 16	61 39	

ϕ, 02 (021). Figures 5, 7, and 8.

	ϕ	ρ	
Crystal 2	0° 00′	66° 10′	poor.
" 5	0 40	65 40	good.
" 6	0 00	66 34	poor.
" 6	0 01	66 00	"
" 8	0 19	65 36	"
" 9	0 00	66 04	"
" 9	0 06	65 43	perfect.
" 12	0 06	65 50	good.
" 14	0 14	65 43	"
Calculated	0 13	65 48	

ψ, 0$\frac{5}{2}$ (052).

	ϕ	ρ	
Crystal 2	0° 00′	69° 48′	fair.
" 14	0 10	70 13	poor.
Calculated	0 11	70 13	

A, $-1\frac{5}{2}$ ($\bar{2}52$). On five crystals, usually with large and distinct faces, of high lustre, giving good reflection (Figures 4 and 7).

	ϕ	ρ	
Crystal 1	−24° 54′	72° 15′	bad.
" 2a	−24 57	71 22	poor.
" 11	−24 24	71 41	good.
" 11	−25 13	71 49	good (in twin position).
" 12	−24 32	71 51	perfect.
" 12	−24 34	71 50	" (in twin position).
" 13	−24 34	71 46	fair.
Calculated	−24 26	71 52	

G, −13 ($\bar{1}31$). Seen but once as a large, distinct, lustrous face with good reflection (Figure 7).

	ϕ	ρ	
Crystal 12	−20° 49′	74° 19′	good.
Calculated	−20 45	74 21	

Y, −21 ($\bar{2}11$). On two crystals, small, not lustrous, and with poor reflections, but certainly a face (Figures 6 and 7).

	ϕ	ρ	
Crystal 7	−66° 01′	71° 15′	bad.
" 12	−66 25	70 12	poor.
" 14	−67 13	70 08	poor (in twin position).
Calculated	−66 19	70 09	

M, $-2\frac{5}{2}$ ($\bar{4}52$). Observed but once as a distinct face with fair reflection (Figure 6).

	ϕ	ρ	
Crystal 7	−42° 01′	75° 21′	fair.
Calculated	−42 22	75 07	

R, −24 ($\bar{2}41$). An important form, found fourteen times on nine crystals, faces distinct and often large, not very lustrous, and reflections often confused with that of (401) in twin position (Figures 3, 4, 7, and 8).

	ϕ	ρ	
Crystal 1	−29° 52′	79° 01′	perfect.
" 1	−30 40	78 15	good (in twin position).
" 2	−29 39	79 10	poor.
" 2a	−29 29	78 53	perfect.
" 3	−30 32	79 00	poor.
" 6	−29 54	78 30	"
" 11	−29 41	78 58	good.
" "	−29 44	79 48	poor.
" "	−28 59	79 26	"
" "	−29 37	78 49	"
" "	−29 33	79 48	"
" 12	−29 18	78 29	"
" 13	−29 43	79 04	"
" 14	−30 56	78 56	fair.
Calculated	−29 41	78 57	

J, $\frac{1}{3}$ (113). Small bright faces with good reflections on six crystals (Figure 8).

	ϕ	ρ	
Crystal 1	49° 24′	29° 35′	good.
" 3	48 49	29 05	poor (in twin position).
" 4	49 03	30 23	good.
" 8	49 57	29 29	fair (in twin position).
" 13	48 59	29 43	good.
" 14	49 18	29 38	"
Calculated	49 24	29 40	

B, $-\frac{1}{3}\ \frac{2}{3}$, ($\bar{1}23$). A poor face on two crystals giving a fair reflection. Not an entirely satisfactory form.

		ϕ	ρ	
Crystal	3	$-30°$ 19′	38° 59′	fair.
"	15	-30 43	40 14	"
Calculated		-29 16	40 22	

N, $\frac{1}{2}\ \frac{5}{4}$ (254). On three crystals with distinct smooth faces, small and of slight lustre (Figure 8).

		ϕ	ρ	
Crystal	1	20° 42′	56° 38′	poor.
"	8	24 22	56 50	good.
"	14	24 51	56 53	fair.
"	14	24 31	54 30	poor.
Calculated		24 53	56 52	

P, $-\frac{1}{2}$ ($\bar{1}12$). Two small faces on the same crystal, very bright, with fine reflection (Figure 6).

		ϕ	ρ	
Crystal	7	$-48°$ 30′	40° 07′	perfect.
"	7	-48 35	40 04	good.
Calculated		-48 27	39 59	

Q, $-\frac{1}{2}\ \frac{3}{4}$ ($\bar{2}34$). Observed on every crystal not broken away in the part where it should occur. Faces often large and generally of high lustre, giving good reflections. A characteristic form for the locality (Figures 2, 3, 4, 5, 6, 7, 8, and 9).

		ϕ	ρ	
Crystal	1	$-36°$ 15′	45° 45′	poor.
"	1	-36 50	46 55	fair (in twin position).
"	2	-37 00	46 04	perfect.
"	2	-36 41	46 35	"
"	2a	-37 00	46 13	good.
"	3	-36 57	46 13	perfect.
"	3	-36 52	46 16	"
"	5	-36 49	46 10	fair.
"	6	-36 42	46 24	poor.
"	6	-37 15	46 04	good.
"	7	-37 07	46 29	poor.
"	8	-36 40	46 50	good.
"	10	-36 46	46 06	perfect.
"	10	-36 32	46 14	good.
"	11	-36 51	48 08	"
"	12	-37 42	46 15	poor.

Crystal 13	−37 10	46 24	poor.
" 14	−36 51	46 17	perfect.
" 14	−37 53	46 16	good.
" 14	−35 59	46 15	poor.
Calculated	−36 57	46 14	

T, $-\frac{1}{2}\ \frac{5}{4}$ ($\bar{2}54$). On two crystals, with small distinct faces, bright, and giving good reflections (Figures 7 and 8).

	ϕ	ρ	
Crystal 8	−24° 41′	56° 48′	good.
" 12	−24 27	56 42	"
Calculated	−24 18	56 45	

U, $\frac{1}{3}\ \frac{1}{2}$ (236). With three faces on two crystals. Faces distinct, but small, and reflections indistinct (Figure 8).

	ϕ	ρ	
Crystal 8	37° 18′	34° 42′	poor.
" 8	38 16	34 52	" (in twin position).
" 13	37 32	35 13	"
Calculated	37 53	35 10	

The following forms have been observed once or more as faces or reflections, but owing to their poor quality, or to the too great discrepancy between observations and calculated values, or for other reasons, they are considered as requiring confirmation :

X, $0\frac{1}{3}$ (013). Not observed as a distinct face (Figure 5).

	ϕ	ρ	
Crystal 15	1° 11′	20° 00′	
" 6	0 44	20 18	
" 12	0 53	19 12	
" 12	1 08	19 53	(in twin position).
" 13	0 44	20 30	
" 13	0 58	19 20	
" 14	0 54	21 23	
" 15	1 19	20 41	
Calculated	1 20	20 21	

Γ, $0\frac{3}{4}$ (034). Observed three times, not as a definite face.

	ϕ	ρ	
Crystal 1	0° 38′	38° 48′	(in twin position).
" 3	0 45	40 25	" " "
" 6	0 34	38 45	
Calculated	0 35	39 50	

$0\frac{5}{6}$ (056). Same remarks as (034).

	ϕ	ρ	
Crystal 8	1° 11′	43° 00′	(in twin position).
" 8	0 09	43 42	
" 14	0 30	43 49	
" 15	0 29	42 50	
Calculated	0 32	42 50	

Λ, 03 (031). Observed but once on a crystal with a rich clinodome zone.

	ϕ	ρ
Crystal 6	1° 32′	73° 13′
Calculated	0 09	73 19

Δ, $-\frac{1}{2}0$ ($\bar{1}02$). Seen but once as a narrow line face truncating the edge between $\bar{2}14$ and $\bar{2}\bar{1}4$. Is probably to be counted with the certain forms (Figure 2).

	ϕ	ρ
Crystal 10	−90° 00′	31° 57′ poor.
Calculated	−90 00	32 06

$\frac{3}{4}0$ (304). Seen but once — a very doubtful form.

	ϕ	ρ
Crystal 1	89° 22′	44° 34
Calculated	90 00	43 55

W, $-2\frac{3}{2}$ ($\bar{4}32$). Seen but twice, faces of very doubtful quality (Figure 7).

	ϕ	ρ
Crystal 6	−56° 31′	72° 00′
" 12	−56 35	70 56
Calculated	−56 40	71 46

H, 2 (221). Observed on two crystals as a narrow line face between 111 and 110. A likely form, but needing better observations to establish it (Figure 8).

	ϕ	ρ
Crystal 8	48° 52′	72° 45′ poor.
" 13	48 19	73 04 bad.
Calculated	48 56	73 33

$-1\frac{1}{4}$ ($\bar{4}14$). Observed three times on two crystals, but variations in position too great to permit of its acceptance (Figure 7).

	ϕ	ρ	
Crystal 6	−77° 36′	52° 00′	bad.
" 6	−78 00	54 00	"
" 12	−76 55	51 01	"
Calculated	−77 35	52 18	

Computation of the Elements. — Since the monoclinic character of leadhillite has been generally accepted, the elements commonly used have been those of Laspeyres[2] and of Artini,[3] determined on crystals from Sardinia.

Laspeyres, $a : b : c = 1.7476 : 1 : 2.2154. \quad \beta = 89° \, 47' \, 38''$
Artini, $a : b : c = 1.7515 : 1 : 2.2261. \quad \beta = 89° \, 31' \, 55''$

The result of our computation of elements, based on the measurements of 112 best faces of 15 crystals of the Utah leadhillite is intermediate between these values:

$$a : b : c = 1.7485 : 1 : 2.2244. \quad \beta = 89° \, 30' \, 28''$$

We have followed Goldschmidt, however, in halving the values of a and c, these elements giving on the whole simpler symbols for the form series, and the elements used by us, therefore, read as follows:

$$a : b : c = 0.8742 : 1 : 1.1122. \quad \beta = 90° \, 29' \, 32,''$$

which are derived from the polar elements, whose computation follows, by the relations,

$$\beta = 180° - \mu, \qquad a = \frac{q_0}{p_0 \sin \mu}, \qquad c = \frac{q_0}{\sin \mu}.$$

Believing that this axial ratio is more thoroughly established than those earlier deduced, we have calculated a new table of angles based upon it to replace that found in Goldschmidt, Winkeltabellen, p. 217 (Table V. p. 460).

In order to test the angles yielded by the new axial ratio as compared with those calculated from Laspeyres' elements as given in Goldschmidt, Winkeltabellen, the following measurements are recorded, made on a very perfect untwinned crystal of leadhillite from Sardinia, under conditions similar to those used in the study of the Utah crystals. Although the differences are of course slight, the agreement is in almost every case better with the new angles.

[2] Zeit. für Kryst., **1**, 193 (1877).
[3] Giorn. Min., **1** 1, (1890).

Form.	Observed.		Calc. P. & LaF.		Calc. Gold.	
	ϕ	ρ	ϕ	ρ	ϕ	ρ
	° ′	° ′	° ′	° ′	° ′	° ′
001	90 00	00 29	90 00	00 30	90 00	00 12
120	29 42	90 00	29 46	90 00	29 47	90 00
101	89 53	51 59	90 00	52 01	90 00	51 49
401	89 57	78 50	90 00	78 54	90 00	78 51
011	00 22	48 07	00 27	48 02	00 11	47 55
111	49 13	59 30	49 02	59 29	48 56	59 20
121	29 53	68 43	29 56	68 43	29 51	68 37
212	66 32	54 23	66 32	54 23	66 27	54 12
$\bar{1}22$	−29 28	52 00	−29 26	51 56	−29 38	51 53
$\bar{2}14$	−66 15	34 25	−66 06	34 28	−66 17	34 33

The calculation of the elements proceeded according to the method of Goldschmidt[4] as follows. For each of the best faces measured the two quantities,

$$x' = \sin\phi \tan\rho$$
$$y' = \cos\phi \tan\rho$$

were calculated, ϕ and ρ being the measured angles for each face and x' and y' the rectangular coördinates of the projection point of the face in gnomonic projection.

Now in the monoclinic system the following relations hold:

$$\left.\begin{aligned} x' &= p\,p_0 + e \\ -x' &= -p\,p_0 + e \end{aligned}\right\} \quad \mathrm{I}$$
$$y' = q\,q_0 \qquad \mathrm{II}$$

where p and q are rational multiples of the elements p_0 and q_0 (coördinates of the unit form) and $e = \cot\mu$.

Since μ could not be measured directly on our crystals, it was necessary to calculate both e and p_0 in equations I and q_0 in equation II, these three quantities being the elements of the mineral which it was desired to determine.

[4] Ueber Lorandit von Allchar in Macedonien, Zeit. für. Kryst., **30**, 281 (1898).

Ten equations were formed by substituting in equations I the various values of p and the averages of all corresponding values of x′ as follows:

(A)	$\frac{1}{3} p_0 + e = .4311$	based on	2	values of	x'
(B)	$-\frac{1}{3} p_0 + e = -.4155$	"	3	"	x'
(C)	$\frac{1}{2} p_0 + e = .6442$	"	6	"	x'
(D)	$-\frac{1}{2} p_0 + e = -.6272$	"	21	"	x'
(E)	$-\frac{4}{3} p_0 + e = -.8392$	"	5	"	x'
(F)	$p_0 + e = 1.2808$	"	10	"	x'
(G)	$-p_0 + e = -1.2635$	"	21	"	x'
(H)	$2 p_0 + e = 2.5556$	"	5	"	x'
(I)	$-2 p_0 + e = -2.5359$	"	11	"	x'
(J)	$4 p_0 + e = 5.0953$	"	4	"	x'

and these equations were solved in pairs for e and p_0 (D), based on the largest number of the best values of x′ being combined with each of the others for this purpose. The following nine values for e and p_0 were thus obtained, weighted in accordance with their relative importance, and combined in a final average. It is the close accordance of these values which seems to attest the reliability of the elements here determined.

D and A	$e = .0078$	$p_0 = 1.2700$
D and B	$e = .0079$	$p_0 = 1.2702$
D and C	$e = .0085$	$p_0 = 1.2714$
D and E	$e = .0088$	$p_0 = 1.2720$
D and F	$e = .0088$	$p_0 = 1.2720$
D and G	$e = .0091$	$p_0 = 1.2726$
D and H	$e = .0094$	$p_0 = 1.2731$
D and I	$e = .0090$	$p_0 = 1.2725$
D and J	$e = .0086$	$p_0 = 1.2717$

Weighted mean, $\cot \mu = e = .0086 \qquad p_0 = 1.2722$

$$\mu = 89^\circ\ 30'\ 28''.$$

In like manner the value of q_0 was found by subsituting in equation II various values of q and the averages of corresponding values of y′, and then weighting and averaging the results.

(A)	$\frac{1}{6} q_0 = 0.1852$	3	values of	y'	$q_0 = 1.1112$
(B)	$\frac{1}{4} q_0 = 0.2779$	7	"	y'	$q_0 = 1.1116$
(C)	$\frac{1}{3} q_0 = 0.3702$	2	"	y'	$q_0 = 1.1106$
(D)	$\frac{1}{2} q_0 = 0.5563$	14	"	y'	$q_0 = 1.1126$
(E)	$\frac{2}{3} q_0 = 0.7421$	4	"	y'	$q_0 = 1.1131$

(F)	$\frac{3}{4}$ $q_0 = 0.8343$	6 values of y'	$q_0 = 1.1124$
(G)	1 $q_0 = 1.1116$	15 " y'	$q_0 = 1.1116$
(H)	$\frac{5}{4}$ $q_0 = 1.3909$	1 " y'	$q_0 = 1.1127$
(I)	$\frac{3}{2}$ $q_0 = 1.6705$	5 " y'	$q_0 = 1.1136$
(J)	2 $q_0 = 2.2231$	7 " y'	$q_0 = 1.1115$
(K)	$\frac{5}{2}$ $q_0 = 2.7793$	4 " y'	$q_0 = 1.1117$
(L)	3 $q_0 = 3.3297$	1 " y'	$q_0 = 1.1099$
(M)	4 $q_0 = 4.4371$	3 " y'	$q_0 = 1.1093$
		Weighted mean,	$q_0 = 1.1122$

Twinning.— The crystals are often twinned, the twinning plane being regarded as the prism m (120) according to the usual twinning law of the species. Three types of twins may be recognized : (1) contact twins of the aragonite type with a face of the twinning plane m as composition plane, seen chiefly in cleavage flakes under the microscope ; (2) contact or lamellar twins, the composition face parallel to a face of v ($\bar{1}22$), (see Figures 8 and 9) ; (3) interpenetration twins in which the faces in normal position and those in twin position are mingled without any apparent system and can only be distinguished by measurement and projection.

The gnomonic projection is particularly useful in the study of such complex twin crystals of this general type where the twin plane is normal to the plane of projection. The projection points of a face and its twin then lie symmetrically on either side of the trace of the twin plane, that is, equidistant from the trace and on a perpendicular to it. This test can be quickly and easily applied in the projection to any face concerning which there is doubt as to whether it is in normal or twin position, and the rule was adopted, after much study in the special case of these crystals, that the position of a face should be accepted as correct, which, tested in this way, gave the simplest indices.

It was noted in applying this test that the prism F (320) is almost at right angles to m ($320 \wedge \bar{1}20 = 89° 32'$), and this relation leads to a certain amount of ambiguity in the interpretation of the twinning. The prism F has been recorded as the twin plane of lamellar twins of leadhillite due to elevation of temperature, but it is not found in the form series of the mineral. Since their planes are so nearly at right angles, twinning on m and on F will produce closely similar effects, and the decision in favor of the former law is somewhat arbitrary, as may be judged from the following statement of the respective relations.

The most striking effect of twinning by either law is the practical superposition of certain faces lying in radial zones. If the twinning be

on (120), the radial zone containing the forms v, r, and R is, in twin position, almost coincident in direction with the positive orthodome zone, and the three forms named correspond in position to the domes w, u, and y.

Twinned on m (120),

		ϕ	ρ
w	(101)	90° 00′	52° 01′
<u>v</u>	($\bar{1}$22) twin	88 58	51 56
u	(201)	90 00	68 37
<u>r</u>	($\bar{1}$21) twin	89 08	68 39
y	(401)	90 00	78 54
<u>R</u>	($\bar{2}$41) twin	89 13	78 57

If on the other hand the twinning is on (320), the above-named pyramid zone occupies in twin position nearly the same direction as before, but the forms correspond to the negative domes f and e.

Twinned on F (320),

		ϕ	ρ
f	($\bar{1}$01)	−90° 00′	51° 39′
<u>v</u>	($\bar{1}$22) twin	−90 06	51 56
e	($\bar{2}$01)	−90 00	68 29
<u>r</u>	($\bar{1}$21) twin	−89 56	68 39

The same relation exists for twinning on (120) between the pyramids t (122) and x (121) and the domes f and e : and for twinning on (320) between t and x and the domes w and u. Hence in twinned crystals any of these pairs of faces usually appears as a single face, which, however, reflects a double or (owing to vicinals) a multiple signal. The face can, however, sometimes be seen to be made up of two very slightly inclined portions separated by an oblique line, the trace of the composition face v (Figures 8 and 9).

The measurements obtained on twinned crystals were too variable to decide between the two laws where the angular differences were so slight; but it was found that the pyramid series v, r, and R occurred repeatedly in twin position with the dome series w, u, and y, and since the negative dome corresponding to y and the positive pyramid corresponding to R were not found on our crystals and are not known for the mineral, it seems necessary to conclude that the twinning is on the first law or m (120).

A second case of approximate superposition of zones by twinning is in the case of the radial zone containing the pyramids ζ, s, δ, μ, q, and Y,

which in twin position by either law lies about six degrees from the direction of the clinodome zone. Here, however, the polar distances of the faces in the two zones are different, and the result of the twinning is generally the formation of wedge-shaped faces dovetailing irregularly into one another (Figure 8).

It will be seen from what has been said that the twinning does not in any way obscure, but rather tends to increase the pseudo-rhombohedral appearance of the crystals. Figure 9 is intended to bring out this striking habit.

Cleavage plates examined under the microscope in polarized light are usually found to be twins of the second kind mentioned, but in thin plates the lamellae appear to be united on the prism m. When a sufficiently thick plate is examined, the lamellae are seen to be oblique to the cleavage, and the composition face was found to be parallel to v ($\bar{1}22$). Twins of the third kind, in polarized light, usually show three sets of axial figures inclined to each other at 60° and they do not give complete extinction in any position.

No chemical analysis was made of this leadhillite, and the optical characters have been only partially determined. The axial angle of a cleavage plate was measured in air and in cedar oil with the following results:

$$2E_{Na} = 19^\circ\ 54' \quad 2E_{Li} = 19^\circ\ 14' \qquad \text{Temp. } 23^\circ \text{ C.}$$
$$2H_{Na} = 13^\circ\ 24' \quad 2H_{Li} = 12^\circ\ 38' \text{ (in cedar oil)} \qquad \text{“} \quad \text{“}$$

The axial angle was observed to grow smaller with increase of temperature, but no successful measurement of the rate of change, nor of the temperature at which it becomes uniaxial, was obtained.

This study was begun at the time of the receipt of the leadhillite, by Palache, but the crystals proved so complex that it was thought best to put the matter aside in the hope that more material would be found for study without breaking up any of the original lot. Several years elapsed, and the investigation was renewed by La Forge, when, by using a part of the finer specimens, material was obtained which sufficed to unravel the complexities of the crystallization. The work was again interrupted by the illness of the last named, and again a long period passed before the results obtained could be put into shape for publication. In its present form the paper has been prepared by Palache, but the observations in large part, and all of the calculations involved, as well as the drawings, are the work of La Forge.

II. LEADHILLITE FROM NEVADA.

By C. Palache.

The results of the investigation of leadhillite from Utah are confirmed and extended in an interesting manner by the study of another occurrence of the mineral recently brought to light by Dr. T. A. Jaggar. In the course of an examination of the Quartette Gold Mine, at Searchlight, Lincoln County, Nevada, Dr. Jaggar collected specimens of the ores which were submitted to the writer for determination of some of the constituent minerals. Much of the ore at present worked is massive cerussite; imbedded in this substance glistening cleavage plates of a pale green mineral were noted which proved to be leadhillite. Careful search revealed a single cavity in the cerussite, lined and partly filled by interlaced tabular crystals of the mineral, which though very small and for the most part fragmentary, proved to be very well adapted to measurement and yielded a surprisingly rich form series.

The other minerals of the ores of this mine are, first and most important, free gold, which occurs in visible particles in a quartz vein-stuff brilliantly stained with blue chrysocolla. Wulfenite is also found implanted on quartz in crystals of two types, one pale yellow with cubical habit showing the forms m (110) μ (430), n (111), e (101), and c (001); the other in deep red tabular crystals showing the forms l (740, e (101), u (102), n (111) and s (113). In a few cavities in massive gray cerussite were crystals of cerussite with the forms b (010), c (001), m (110), x (120), γ (013), i (021), z (041), y (102), and e (101). Many ore surfaces are covered with a drusy black coating, greenish when rubbed, which proves to be cuprodescloizite in crystals too minute to be interpreted. Calcite, malachite, and hematite are abundant in crevices of the brecciated vein material and wall-rock. Sulphide ores, except minute amounts of galena, have not yet been met with in the mine.

The crystals of leadhillite are always tabular, and most of those measured had one or both of the basal planes as crystal faces rather than as cleavage. The tiny tables, rarely more than a millimeter across, were attached to the cavity wall by an edge and projected freely, so that faces were present in both upper and lower octants, requiring two adjustments on the goniometer for complete measurement. Some seventeen crystals were measured, and yielded the forms shown in Table III. The crystals proved to be largely free from twinning, and when twinned the two individuals were in contact rather than interpenetrating, so that the interpretation of the results of measure-

TABLE III.

Letter.	Symbol — Gdt.	Symbol — Miller.	Calculated. ϕ	Calculated. ρ	Observed Mean. ϕ	Observed Mean. ρ	Differences in Minutes. ϕ +	Differences in Minutes. ϕ −	Differences in Minutes. ρ +	Differences in Minutes. ρ −	Quality of Reflection.	No. of Faces.	No. of Crystals.
			° ′	° ′	° ′	° ′	′	′	′	′			
c	0	001	90 00	00 30	90 00	00 30	..	..	14	10	perfect	19	14
b	0∞	010	00 00	90 00	00 00	90 00	..	..	..	..	good	11	10
a	$\infty 0$	100	90 00	90 00	90 00	90 00	02	10	..	..	perfect	12	11
j[1]	4∞	410	77 40	90 00	77 32	90 00	02	27	..	..	good	6	6
d	2∞	210	66 23	90 00	66 18	90 00	06	29	..	..	fair	8	7
l	∞	110	48 50	90 00	48 49	90 00	16	20	..	..	good	11	9
L	$\frac{2}{3}\infty$	230	37 20	90 00	37 20	90 00	14	7	..	..	good	6	5
m	$\infty 2$	120	29 46	90 00	29 46	90 00	12	15	..	..	good	17	12
ν	$0\frac{1}{4}$	014	1 46	15 33	00	15 34	..	..	..	..	..	1	1
χ	$0\frac{1}{3}$	013	1 20	20 21	39	20 22	..	41	19	17	poor	2	2
α	$0\frac{1}{2}$	012	53	29 05	39	28 54	..	14	..	11	poor	1	1
Γ	$0\frac{3}{4}$	034	35	39 50	20	39 50	4	35	6	9	poor	3	3
h	$0\frac{3}{2}$	032	18	59 04	15	59 04	7	15	7	10	fair	5	5
g	01	011	27	48 02	18	48 06	7	27	13	9	good	6	6
ϕ	02	021	13	65 48	06	65 56	2	13	21	16	fair	11	8
Λ	03	031	09	73 19	05	73 20	8	4	6	2	fair	3	2
y	40	401	90 00	78 54	90 00	78 39	..	..	6	54	poor	3	3
u	20	201	90 00	68 37	90 00	68 38	3	..	21	2	poor	6	6
z	$\frac{3}{2}0$	302	90 00	62 27	90 00	61 45	..	..	..	42	poor	1	1
C[1]	$\frac{4}{3}0$	403	90 00	59 36	90 00	59 45	..	..	9	..	fair	1	1
w	10	101	90 00	52 01	90 00	52 02	3	..	8	7	fair	7	8
i	$\frac{2}{3}0$	203	90 00	40 35	90 00	40 50	..	..	41	..	poor	3	3
D	$\frac{1}{2}0$	$\bar{1}02$	90 00	32 48	90 15	32 30	15	..	..	18	good	1	1
f	−10	$\bar{1}01$	−90 00	51 39	−90 00	51 47	..	..	31	4	poor	4	4
e	−20	$\bar{2}01$	−90 00	68 29	−90 00	68 32	..	9	19	4	fair	4	4
k	1	111	49 02	59 29	49 01	59 33	13	14	18	9	good	9	8
s	$1\frac{1}{2}$	212	66 32	54 23	66 32	54 26	9	16	4	15	good	7	6
θ	$1\frac{3}{2}$	232	37 31	64 34	37 29	64 38	17	14	19	6	good	7	6
x	12	121	29 56	68 43	29 57	68 41	5	7	17	10	perfect	8	7
I[1]	$1\frac{5}{9}$	252	24 44	71 54	24 49	71 55	5	..	1	..	fair	1	1
K[1]	13	$\bar{1}31$	21 00	74 22	20 57	74 27	..	7	11	..	good	3	2
q	$-1\frac{1}{2}$	$\bar{2}12$	−66 15	54 05	−66 12	54 03	18	10	14	12	good	9	8
p	−11	$\bar{1}11$	−48 39	59 17	−48 34	59 17	10	31	7	8	good	9	7
o	$-1\frac{3}{2}$	$\bar{2}32$	−37 09	64 28	−37 11	64 26	15	9	7	13	good	7	6
r	−12	$\bar{1}21$	−29 39	68 39	−29 35	68 38	12	21	14	17	good	11	10
A	$-1\frac{7}{2}$	$\bar{2}52$	−24 26	71 52	−24 29	71 48	17	2	5	22	perfect	5	4
G	−13	$\bar{1}31$	−20 45	74 21	−20 39	74 31	..	12	23	..	fair	3	3
n	$-1\frac{7}{2}$	$\bar{2}72$	−17 59	76 16	−18 06	76 31	19	3	28	6	fair	5	5
S[1]	−14	$\bar{1}41$	−15 51	77 48	−15 47	77 57	7	12	12	..	fair	3	3
V[1]	$-1\frac{9}{2}$	$\bar{2}92$	−14 10	79 02	−14 07	79 14	..	..	3	12	..	1	1
ω	$2\frac{1}{2}$	412	77 43	69 03	77 41	69 09	11	7	12	..	good	5	5
ζ	21	211	66 28	70 15	66 31	70 08	8	0	13	2	fair	6	5

[1] New forms.

TABLE III. — *Continued.*

Letter.	Symbol. — Gdt.	Symbol — Miller.	Calculated. ϕ	Calculated. ρ	Observed Mean. ϕ	Observed Mean. ρ	Differences in Minutes. ϕ +	ϕ −	ρ +	ρ −	Quality of Reflection.	No. of Faces.	No. of Crystals.
							′	′	′	′			
γ	31	$\underline{3}11$	73 47	75 55	73 47	75 56	4	7	20	15	good	6	5
ρ	$-2\frac{1}{2}$	$\underline{4}12$	−77 38	68 55	−77 32	68 55	4	20	8	9	fair	6	6
Y	−21	$\bar{2}11$	−66 19	70 09	−66 08	70 11	4	25	5	1	poor	2	2
W	$-2\frac{3}{2}$	$\underline{4}32$	−56 40	71 46	−56 35	71 47	4	15	10	2	fair	4	4
X[1]	−22	$\underline{2}21$	−48 45	73 29	−48 39	73 31	6	25	6	8	poor	5	5
M	$-2\frac{5}{2}$	$\underline{4}52$	−42 22	75 07	−42 23	75 17	9	8	27	4	poor	4	3
Z[1]	−23	$\underline{2}31$	−37 14	76 35	−37 04	76 37	..	10	2	..	fair	1	1
R	−24	$\underline{2}41$	−29 41	78 57	−29 44	79 00	3	..	3	..	fair	2	2
Σ[1]	$-\frac{3}{2}\ \frac{1}{4}$	$\bar{6}14$	−81 40	62 29	−81 35	62 39	7	16	18	..	poor	3	2
β	$\frac{1}{3}\ \frac{2}{3}$	123	30 16	40 39	30 11	40 42	..	5	3	..	perfect	1	1
Φ[1]	$\frac{1}{3}\ \frac{5}{6}$	$\underline{2}56$	25 01	45 39	25 05	45 39	4	..	..	..	fair	1	1
λ	$-\frac{1}{3}\ \frac{1}{6}$	$\underline{2}16$	−65 57	24 28	−65 34	24 30	..	44	13	9	fair	2	1
B	$-\frac{1}{3}\ \frac{2}{3}$	$\bar{1}23$	−29 16	40 22	−29 29	40 18	21	..	5	10	poor	3	2
δ	$\frac{1}{2}\ \frac{1}{4}$	214	66 40	35 04	66 49	34 56	20	1	..	13	poor	2	2
ϵ	$\frac{1}{2}\ \frac{1}{2}$	112	49 13	40 25	49 17	40 20	7	..	1	10	good	2	2
Ψ[1]	$\frac{1}{2}\ \frac{3}{4}$	234	37 42	46 30	37 30	46 27	..	12	..	3	perfect	1	1
t	$\frac{1}{2}$ 1	122	30 06	52 07	30 14	52 03	31	8	5	13	good	4	3
N	$\frac{1}{2}\ \frac{5}{4}$	254	24 53	56 52	24 53	57 03	..	..	11	..	poor	1	1
Ω[1]	$\frac{1}{2}\ \frac{3}{2}$	$\underline{1}32$	21 08	60 47	21 13	60 54	9	8	9	..	poor	3	2
μ	$-\frac{1}{2}\ \frac{1}{4}$	$\underline{2}14$	−66 06	34 28	−66 14	34 20	16	..	..	10	fair	2	1
P	$-\frac{1}{2}\ \frac{1}{2}$	$\underline{1}12$	−48 27	39 59	−48 37	39 59	20	5	18	9	poor	3	2
Q	$-\frac{1}{2}\ \frac{3}{4}$	$\bar{2}34$	−36 57	46 14	−37 18	46 17	21	..	3	..	good	1	1
v	$-\frac{1}{2}$ 1	$\underline{1}22$	−29 26	51 56	−29 27	51 51	22	10	7	32	good	9	7
O[1]	$-\frac{2}{3}\ \frac{1}{2}$	$\underline{4}36$	−56 29	45 12	−56 49	45 02	20	..	..	10	fair	1	1
C[1]	$-\frac{7}{8}\ \frac{3}{4}$	$\bar{7}68$	−52 56	54 09	−52 57	54 16	1	..	7	..	perfect	1	1

[1] New forms.

ment was much less difficult than in the case of the Utah leadhillite. But the crystals were so fragmentary and so complex, and there was such an entire lack of features by which the forms could be identified on inspection, that it was only by means of the graphic treatment of the measurements in gnomonic projection that they could be clearly understood. Adjustment on the goniometer was always made approximately by means of the base and accurately by the never-failing prism zone.

Of the sixty-seven forms observed, fourteen were new, bringing the total forms known for the mineral to seventy-seven. Of equal interest with the new forms, however, was the observation on this material of

many of the forms first found on the Utah leadhillite, and particularly of the best established ones. Ten of the Utah forms regarded as certain and five of those considered doubtful were found on the Nevada material, furnishing a welcome confirmation of the results recorded in the preceding paper. Moreover, the thirteen Utah forms not observed here were with one exception weak or uncertain forms.

Only two of the forms known on leadhillite previous to this investigation were not observed. The first of these, σ ($\bar{2}33$), was first found by Artini as a minute face; he could obtain no measurements and regarded it as doubtful. One face was found on a crystal from Utah near this position, and the form is probably to be regarded as established.

The second form, τ ($\bar{4}$. 14. 7), with complex symbol and abnormal position in the form system of leadhillite, is a dubious form, probably to be replaced by the simpler form ($\bar{1}42$), which is not far removed. This possibility was, however, considered by Artini and rejected. He observed a single face of the form, the observed zonal relations and angles of which seemed to him to preclude its interpretation as ($\bar{1}42$).

The combinations observed are shown in Table IV. As was the case with the Utah crystals, the forms most frequently found are c, a, m, and r, which are present on nearly every crystal. b, d, l, g, ϕ, u, w, k, x, q, and v are present on at least half the crystals. Of the remaining forms the new prism, j, and the pyramids A, n, γ, and ρ are the most important, all others being of very rare occurrence.

The new forms on the leadhillite from Nevada, with which will be included the five uncertain Utah forms here confirmed, are based on the following data:

j, 4 ∞ (410). A prism, well established by frequent occurrence with distinct faces, often of good quality.

	ϕ	ρ	
Crystal 3	77° 30′	90° 00′	poor.
" 7	77 42	"	perfect.
" 9	77 13	"	"
" 10	77 33	"	poor.
" 12	77 35	"	very poor.
" 14	77 40	"	fair.
Calculated	77 40	90 00	

χ, 0⅓ (013). Seen twice as a distinct face in the clinodome zone. Reflections poor. Found also on the Utah leadhillite, and hence regarded as assured.

TABLE IV.

Nevada Leadhillite.

Cryst. No.	c	b	a	j	d	l	L	m	ν	χ	α	Γ	g	h	φ	Λ	y	u	z	C	w	i	D	f	e	k	s	θ	x	I	K	q	p
1	×	×							×	×		×	×																				
2	×		×			×		×																		×	×	×	×				
3	×		×	×				×										×	×		×	×			×	×			×			×	
4	×	×	×					×							×														×				
5	×		×		×	×	×											×			×					×	×						
6	×		×					×																×									
7	×		×	×	×	×	×	×																	×							×	×
8	×	×	×		×	×							×	×	×			×			×					×	×	×	×			×	
9	×	×	×	×	×	×		×				×					×	×			×				×	×		×	×			×	×
10	×	×	×	×	×	×	×	×					×	×	×	×	×	×			×					×	×	×	×		×		
11	×	×						×		×	×	×	×		×	×					×								×	×	×		
12	×		×	×	×	×	×	×									×									×		×	×			×	×
13	×	×	×										×	×	×			×			×	×		×								×	×
14	×	×	×	×	×	×		×					×	×	×		×	×		×	×	×		×	×	×	×	×	×		×	×	×
15	×	×	×			×	×	×					×	×	×						×								×		×	×	×
16	×	×											×	×	×																		
17	×		×	×	×	×	×	×									×	×			×	×	×	×	×	×	×		×			×	×

Cryst. No.	o	r	A	G	n	S	V	ω	ζ	γ	ρ	Y	W	X	M	Z	R	Σ	β	Φ	λ	B	δ	ε	Ψ	t	N	Ω	μ	P	Q	v	Θ	O
1																																		
2								×		×																								
3		×						×																		×								
4																																		
5								×	×	×																								
6		×																																
7	×	×									×	×	×																			×		
8								×		×																								
9		×	×	×	×				×	×	×	×	×	×			×						×				×					×		
10		×	×	×	×	×	×		×		×		×			×	×											×				×		×
11		×			×	×											×									×	×	×				×		
12	×	×							×	×	×			×	×																			
13	×	×	×	×	×						×											×								×	×	×		
14	×	×	×	×	×			×	×	×	×			×	×			×	×	×				×	×	×	×					×		
15	×	×	×	×	×	×								×								×								×	×	×	×	
16	×	×	×		×																											×		
17	×	×	×						×	×	×		×	×	×			×	×		×	×	×	×		×			×	×	×	×		

		ϕ	ρ	
Crystal	1	00° 00′	20° 04′	fair.
"	11	00 39	20 40	poor.
Calculated		1 20	20 21	

Γ, $0\frac{3}{4}$ (034). On three crystals as narrow faces with poor reflections but in good position. Also observed on Utah material.

	ϕ	ρ	
Crystal 1	00° 00′	39° 52′	poor.
" 9	00 00	39 56	very poor.
" 11	00 39	39 41	fair.
Calculated	00 35	39 50	

Λ, 03 (031). Seen on two crystals with three faces, two of them large and distinct, giving good reflections, in excellent agreement with calculated position. Since it was also observed once on Utah crystals, the form is well established.

	ϕ	ρ	
Crystal 10	00° 05′	73° 25′	perfect.
" 10	00 17	72 42	very poor.
" 11	00 09	73 17	fair.
Calculated	00 09	73 19	

C, $\frac{4}{3}0$ (403). This dome was seen but once as a distinct though narrow face in the orthodome zone. Although the reflection was poor, it is in good position and the form is regarded as established.

	ϕ	ρ	
Crystal 14	90° 00′	59° 45′	poor.
Calculated	90 00	59 36	

I, $1\frac{5}{2}$ (252). Observed but once as a distinct face in an important zone in excellent position.

	ϕ	ρ	
Crystal 11	24° 49′	71° 55′	fair.
Calculated	24 44	71 54	

K, 13 (131). Observed twice on one crystal and once on a second with excellent faces. It is in the same zone with the foregoing and in excellent position.

	ϕ	ρ	
Crystal 10	21° 00′	74° 24′	good.
" 10	20 59	74 26	"
" 11	20 58	74 25	"
Calculated	21 00	74 22	

S, $\bar{1}4$ ($\bar{1}41$). Observed on two crystals as a narrow line face in an important zone and on a third as a larger face with excellent reflection in good position.

	ϕ	ρ	
Crystal 10	−15° 44′	78° 00′	poor.
" 11	−15 46	77 52	perfect.
" 15	−15 58	77 56	fair.
Calculated	−15 51	77 48	

V, $\bar{1}\frac{9}{2}$ ($\bar{2}92$). Observed but once as a distinct facet in the same zone with the last and established by its good position.

	ϕ	ρ
Crystal 10	−14° 10′	79° 09′
Calculated	−14 10	79 02

W, $\bar{2}\frac{3}{2}$ ($\bar{4}32$). This form, which was observed twice on Utah crystals but could not be established, was found on four crystals with distinct faces in good position. With the two following forms it is in an important zone.

	ϕ	ρ	
Crystal 7	−56° 37′	71° 44′	fair.
" 9	−56 25	71 45	perfect.
" 10	−56 36	71 45	fair.
" 17	−56 44	71 56	poor.
Calculated	−56 40	71 46	

X, $\bar{2}$, ($\bar{2}21$). Observed on five crystals and in good position despite the poor quality of the reflections.

	ϕ	ρ	
Crystal 9	−48° 20′	73° 21′	poor.
" 12	−48 40	73 35	fair.
" 14	−48 40	73 35	"
" 15	−48 43	73 35	very poor.
" 17	−48 51	73 28	poor.
Calculated	−48 45	73 29	

Z, $\bar{2}3$ ($\bar{2}31$). Observed once as a distinct facet in the zone [$\bar{1}21 \wedge \bar{1}10$] and in good position.

	ϕ	ρ	
Crystal 10	−37° 08′	76° 30′	fair.
Calculated	−37 14	76 35	

Σ, $\frac{\bar{3}}{2}\frac{1}{4}$ ($\bar{6}14$). Observed three times on two crystals as distinct facets. Accepted despite the poor quality of faces and somewhat variable position because of its simple position in the zone [$\bar{2}01 \wedge 011$].

	ϕ	ρ	
Crystal 14	−81° 43′	62° 40′	poor.
" 14	−80 07	62 30	fair.
" 17	−81 34	62 36	"
Calculated	−81 40	62 29	

Φ, $\frac{1}{3}\ \frac{5}{6}$ (256). Observed as a distinct face with good reflection on a single crystal, in the zone [012 ∧ 122]. Position good.

	ϕ	ρ	
Crystal 14	25° 00′	45° 35′	fair.
Calculated	25 01	45 39	

Ψ, $\frac{1}{2}\ \frac{3}{4}$ (234). Observed as a distinct face with good reflection on the same crystal as the last, in the zone [111 ∧ 123]. Confirmed by its good position.

	ϕ	ρ	
Crystal 14	37° 33′	46° 24′	good.
Calculated	37 42	46 30	

Ω, $\frac{1}{2}\ \frac{3}{2}$ (132). Observed with two faces on one crystal and one on a second, small and with poor reflections. Accepted, however, because of its good position and place in an important zone.

	ϕ	ρ	
Crystal 10	21° 17′	60° 50′	poor.
" 10	21 09	61 00	fair.
" 11	21 12	60 53	poor.
Calculated	21 08	60 47	

Θ, $\bar{\frac{2}{3}}$, $\frac{1}{2}$ ($\bar{4}36$). Observed but once as a distinct face with fine reflection. The position is not wholly satisfactory.

	ϕ	ρ	
Crystal 15	−56° 49′	45° 02′	fair.
Calculated	−56 29	45 12	

O, $\bar{\frac{7}{8}}\ \frac{3}{4}$ ($\bar{7}68$.) Observed but once as a large distinct face with perfect reflection. The position of the face is extremely close to that of the common form q ($\bar{2}12$) in twin position; but as the crystal on which it occurs shows no other indications of twinning, as the form lies in the important zone [$\bar{2}01$ ∧ $\bar{1}22$], and as the measured angles agree more closely with the calculated position of this form than with those of q in twin position, the form is regarded as assured despite its somewhat complex symbol.

	ϕ	ρ	
Crystal 10	−52° 57′	54° 16′	perfect.
Calculated, twin of q	−53 17	54 05	
Calculated ($\bar{7}68$)	−52 56	54 09	

TABLE V.

LEADHILLITE. *Monoclinic.*

$a = 0.8742$	$\log a = 9.94165$	$\log a_0 = 9.89546$	$\log p_0 = 0.10454$	$a_0 = 0.7861$	$p_0 = 1.2721$
$c = 1.1122$	$\log c = 0.04618$	$\log b_0 = 9.95382$	$\log q_0 = 0.04618$	$b_0 = 0.8992$	$q_0 = 1.1122$
$\left.\begin{matrix}\mu = \\ 180° - \beta\end{matrix}\right\} 89° 30\tfrac{1}{2}'$	$\left.\begin{matrix}\log h = \\ \log \sin \mu\end{matrix}\right\} 9.99998$	$\left.\begin{matrix}\log e = \\ \log \cos \mu\end{matrix}\right\} 7.93398$	$\log \frac{p_0}{q_0} = 0.05836$	$h = 0.99996$	$e = 0.0086$

Number.	Letter.	Symbol—Gdt.	Symbol—Miller.	ϕ	ρ	ξ_0	η_0	ξ	η	x′	y′	d′ = tan ρ
				° ′	° ′	° ′	° ′	° ′	° ′			
1	c	0	001	90 00	0 30	0 30	0 00	0 30	0 00	0.0086	0	0.0086
2	b	0∞	010	0 00	90 00	0 00	90 00	0 00	90 00	0	∞	∞
3	a	∞0	100	90 00	"	90 00	0 00	90 00	0 00	∞	0	"
4	j	4∞	410	77 40	"	"	90 00	77 40	12 20	4.5753 [1]	∞	"
5	d	2∞	210	66 23	"	"	"	66 23	23 37	2.2877 [1]	"	"
6	F	$\frac{3}{2}$∞	320	59 46	"	"	"	59 46	30 14	1.7158 [1]	"	"
7	l	∞	110	48 50	"	"	"	48 50	41 10	1.1439 [1]	"	"
8	L	$\frac{2}{3}$∞	230	37 20	"	"	"	37 20	52 40	0.7626 [1]	"	"
9	m	∞2	120	29 46	"	"	"	29 46	60 14	0.5719 [1]	"	"
10	ν	0$\frac{1}{4}$	014	1 46	15 33	0 30	15 32	0 28	15 32	0.0086	0.2780	0.2782
11	χ	0$\frac{1}{3}$	013	1 20	20 21	"	20 21	0 28	20 20	"	0.3707	0.3708
12	a	0$\frac{1}{2}$	012	0 53	29 05	"	29 05	0 26	29 05	"	0.5561	0.5561
13	η	0$\frac{2}{3}$	023	0 40	36 33	"	36 33	0 24	36 33	"	0.7414	0.7414
14	Γ	0$\frac{3}{4}$	034	0 35	39 50	"	39 50	0 23	39 50	"	0.8341	0.8341
15	g	01	011	0 27	48 2	"	48 02	0 20	48 02	"	1.1121	1.1121
16	h	0$\frac{3}{2}$	032	0 18	59 04	"	59 04	0 15	59 04	"	1.6682	1.6682
17	π	0$\frac{5}{3}$	053	0 16	61 39	"	61 39	0 14	61 39	"	1.8535	1.8535
18	ϕ	02	021	0 13	65 48	"	65 48	0 12	65 48	"	2.2242	2.2242
19	ψ	0$\frac{5}{2}$	052	0 11	70 13	"	70 13	0 10	70 13	"	2.7803	2.7803
20	Λ	03	031	0 09	73 19	"	73 19	0 08	73 19	"	3.3363	3.3363
21	y	$\overset{+}{4}$0	401	90 00	78 54	78 54	0 00	78 54	0 00	5.0974	0	5.0972

[1] $\frac{x'}{y'}$.

TABLE V — *Continued.*

Number.	Letter.	Symbol—Gdt.	Symbol—Miller.	ϕ	ρ	ξ_0	η_0	ξ	η	x′	y′	d′ = tan ρ
				° ′	° ′	° ′	° ′	° ′	° ′			
22	u	$\overset{+}{2}0$	201	"	68 37	68 37	"	68 37	"	2.5529	"	2.5529
23	z	$\overset{+}{\tfrac{3}{2}}0$	302	"	62 27	62 27	"	62 27	"	1.9168	"	1.9168
24	C	$\overset{+}{\tfrac{4}{3}}0$	403	"	59 36	59 36	"	59 36	"	1.7045	"	1.7045
25	w	$\overset{+}{1}0$	101	"	52 01	52 01	"	52 01	"	1.2808	"	1.2808
26	i	$\overset{+}{\tfrac{2}{3}}0$	203	"	40 35	40 35	"	40 35	"	0.8567	"	0.8567
27	D	$\overset{+}{\tfrac{1}{2}}0$	102	"	32 48	32 48	"	32 48	"	0.6446	"	0.6446
28	E	$\overset{-}{\tfrac{2}{3}}0$	$\bar{2}03$	−90 00	40 01	−40 01	"	−40 01	"	−0.8395	"	0.8395
29	f	$\overset{-}{1}0$	$\bar{1}01$	"	51 39	−51 39	"	−51 39	"	−1.2636	"	1.2636
30	e	$\overset{-}{2}0$	$\bar{2}01$	"	68 29	−68 29	"	−68 29	"	−2.5357	"	2.5357
31	k	$\overset{+}{1}$	111	49 02	59 29	52 01	48 02	40 35	34 23	1.2808	1.1121	1.6962
32	s	$\overset{+}{1}\tfrac{1}{2}$	212	66 32	54 23	"	29 05	48 13	18 54	"	0.5561	1.3963
33	θ	$\overset{+}{1}\tfrac{3}{2}$	232	37 31	64 34	"	59 04	33 22	45 45	"	1.6682	2.1032
34	x	$\overset{+}{1}2$	121	29 56	68 43	"	65 48	27 43	53 51	"	2.2242	2.5666
35	I	$\overset{+}{1}\tfrac{5}{2}$	252	24 44	71 54	"	70 13	23 20	59 42	"	2.7800	3.0610
36	K	$\overset{+}{1}3$	131	21 00	74 22	"	73 19	20 11	64 02	"	3.3363	3.5740
37	q	$\overset{-}{1}\tfrac{1}{2}$	$\bar{2}12$	−66 15	54 05	−51 39	29 05	−47 50	19 02	−1.2636	0.5561	1.3805
38	p	$\overset{-}{1}1$	$\bar{1}11$	−48 39	59 17	"	48 02	−40 12	34 37	"	1.1121	1.6833
39	o	$\overset{-}{1}\tfrac{3}{2}$	$\bar{2}32$	−37 09	64 28	"	59 04	−33 01	46 00	"	1.6682	2.0927
40	r	$\overset{-}{1}2$	$\bar{1}21$	−29 36	68 39	"	65 48	−27 23	54 05	"	2.2242	2.5581
41	A	$\overset{-}{1}\tfrac{5}{2}$	$\bar{2}52$	−24 26	71 52	"	70 13	−23 09	59 54	"	2.7803	3.0539
42	G	$\overset{-}{1}3$	$\bar{1}31$	−20 45	74 21	"	73 19	−19 56	64 13	"	3.3363	3.5676
43	n	$\overset{-}{1}\tfrac{7}{2}$	$\bar{2}72$	−17 59	76 16	"	75 36	−17 27	67 31	"	3.8924	4.0923
44	S	$\overset{-}{1}4$	$\bar{1}41$	−15 51	77 48	"	77 20	−15 29	70 05	"	4.4484	4.6240
45	V	$\overset{-}{1}\tfrac{9}{2}$	$\bar{2}92$	−14 10	79 02	"	78 42	−13 54	72 09	"	5.0045	5.1620
46	ω	$\overset{+}{2}\tfrac{1}{2}$	412	77 43	69 03	68 37	29 05	65 52	11 28	2.5529	0.5561	2.6128
47	ζ	$\overset{+}{2}1$	211	66 28	70 15	"	48 02	59 38	22 05	"	1.1121	2.7847
48	γ	$\overset{+}{3}1$	311	73 47	75 55	75 21	48 02	68 39	15 43	3.8251	"	3.9836
49	ρ	$\overset{-}{2}\tfrac{1}{2}$	$\bar{4}12$	−77 38	68 55	−68 29	29 05	−65 43	11 32	−2.5357	0.5561	2.5960
50	Y	$\overset{-}{2}1$	$\bar{2}11$	−66 19	70 09	"	48 02	−59 28	22 12	"	1.1121	2.7689
51	W	$\overset{-}{2}\tfrac{3}{2}$	$\bar{4}32$	−56 40	71 46	"	59 04	−52 31	31 28	"	1.6682	3.0352
52	X	$\overset{-}{2}2$	$\bar{2}21$	−48 45	73 29	"	65 47	−46 07	39 12	"	2.2242	3.3730
53	M	$\overset{-}{2}\tfrac{5}{2}$	$\bar{4}52$	−42 22	75 07	"	70 13	−40 38	45 34	"	2.7803	3.7630

TABLE V — *Continued.*

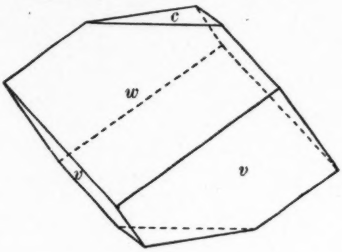
Number.	Letter.	Symbol—Gdt.	Symbol—Miller.	ϕ	ρ	ξ_0	η_0	ξ	η	x′	y′	d′ = tan ρ
				° ′	° ′	° ′	° ′	° ′	° ′			
54	Z	$\bar{2}3$	$\bar{2}31$	−37 14	76 35	"	73 19	−36 03	50 45	"	3.3363	4.1910
55	R	$\bar{2}4$	$\bar{2}41$	−29 41	78 57	"	77 20	−29 05	58 30	"	4.4485	5.1205
56	Σ	$\bar{\tfrac{3}{2}}\ \tfrac{1}{4}$	$\bar{6}14$	−81 40	62 29	−62 14	15 32	−61 20	7 23	−1.8995	0.2780	1.9199
57	J	$\overset{+}{\tfrac{1}{3}}$	113	49 24	29 40	23 24	20 20	22 05	18 47	0.4326	0.3707	0.5697
58	U	$\overset{+}{\tfrac{1}{3}}\ \tfrac{1}{2}$	236	37 53	35 10	23 24	29 05	20 43	27 02	"	0.5561	0.7045
59	β	$\overset{+}{\tfrac{1}{3}}\ \tfrac{2}{3}$	123	30 16	40 39	"	36 33	19 10	34 14	"	0.7414	0.8584
60	Φ	$\overset{+}{\tfrac{1}{3}}\ \tfrac{5}{6}$	256	25 01	45 39	"	42 49	17 36	40 22	"	0.9268	1.0227
61	λ	$\bar{\tfrac{1}{3}}\ \tfrac{1}{6}$	$\bar{2}16$	−65 57	24 28	−22 34	10 30	−22 13	9 43	−0.4154	0.1854	0.4549
62	B	$\bar{\tfrac{1}{3}}\ \tfrac{2}{3}$	$\bar{1}23$	−29 16	40 22	"	36 33	−18 27	34 24	"	0.7414	0.8499
63	δ	$\overset{+}{\tfrac{1}{2}}\ \tfrac{1}{4}$	214	66 40	35 04	32 48	15 32	31 51	13 09	0.6446	0.2780	0.7020
64	ϵ	$\overset{+}{\tfrac{1}{2}}$	112	49 13	40 25	"	29 05	29 24	25 03	"	0.5561	0.8513
65	Ψ	$\overset{+}{\tfrac{1}{2}}\ \tfrac{3}{4}$	234	37 42	46 30	"	39 50	26 20	35 02	"	0.8341	1.0541
66	t	$\overset{+}{\tfrac{1}{2}}\ 1$	122	30 06	52 07	"	48 02	23 19	43 04	"	1.1121	1.2854
67	N	$\overset{+}{\tfrac{1}{2}}\ \tfrac{5}{8}$	458	24 53	56 52	"	54 16	20 38	49 27	"	1.3901	1.5323
68	Ω	$\overset{+}{\tfrac{1}{2}}\ \tfrac{3}{2}$	132	21 08	60 47	"	59 04	18 20	54 30	"	1.6682	1.7881
69	μ	$\bar{\tfrac{1}{2}}\ \tfrac{1}{4}$	$\bar{2}14$	−66 06	34 28	−32 06	15 32	−31 09	13 15	−0.6274	0.2780	0.6863
70	P	$\bar{\tfrac{1}{2}}\ \tfrac{1}{2}$	$\bar{1}12$	−48 27	39 59	"	29 05	−28 44	25 13	"	0.5561	0.8384
71	Q	$\bar{\tfrac{1}{2}}\ \tfrac{3}{4}$	$\bar{2}34$	−36 57	46 14	"	39 50	−25 44	35 15	"	0.8341	1.0437
72	v	$\bar{\tfrac{1}{2}}1$	$\bar{1}22$	−29 26	51 56	"	48 02	−22 46	43 17	"	1.1121	1.2769
73	T	$\bar{\tfrac{1}{2}}\ \tfrac{5}{4}$	$\bar{2}54$	−24 18	56 45	"	54 16	−20 07	49 40	"	1.3901	1.5251
74	τ	$\bar{\tfrac{4}{7}}2$	$\bar{4}.14.7$	−17 54	66 50	−35 42	65 48	−16 25	61 02	−0.7183	2.2242	2.3373
75	Θ	$\bar{\tfrac{2}{3}}\ \tfrac{1}{2}$	$\bar{4}36$	−56 29	45 12	−40 01	29 05	−36 16	23 04	−0.8395	0.5561	1.0070
76	σ	$\bar{\tfrac{2}{3}}1$	$\bar{2}33$	−37 03	54 20	"	48 02	−29 19	40 25	"	1.1121	1.3934
77	O	$\bar{\tfrac{7}{8}}\ \tfrac{3}{4}$	$\bar{7}68$	−52 56	54 09	−47 50	39 50	−40 18	29 14	−1.1045	0.8341	1.3841
78	[1]	$0\tfrac{5}{6}$	056	0 32	42 50	0 30	42 49	0 22	42 49	0.0086	0.9268	0.9268
79	[1]	$\overset{+}{\tfrac{3}{4}}0$	304	90 00	43 55	43 55	0 00	43 55	0 00	0.9627	0.0	0.9627
80	Δ[1]	$\bar{\tfrac{1}{2}}0$	$\bar{1}02$	−90 00	32 06	−32 06	0 00	−32 06	0 00	−0.6274	0.0	0.6274
81	[1]	$\bar{\tfrac{2}{3}}\ \tfrac{2}{3}$	$\bar{2}23$	−29 31	59 36	−40 01	56 00	−25 09	48 38	−0.8395	1.4829	1.7040
82	[1]	$\bar{1}\tfrac{1}{8}$	$\bar{8}18$	−77 35	52 18	−51 39	15 32	−50 36	9 43	−1.2636	0.2780	1.2938
83	H[1]	$\overset{+}{2}$	221	48 56	73 33	68 37	65 48	46 19	39 03	2.5529	2.2242	3.3860

[1] Uncertain forms.

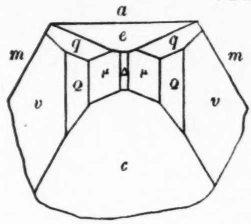
The combination shown in Figure 10 does not exactly correspond to any of the measured crystals, although the forms present differ but little from those observed on one crystal (Table IV, p. 456, no. 13), which is, however, even more complex. It reproduces approximately the more complex type of combination prevailing among the Nevada crystals and illustrates the relations of most of the new forms.

The amount of leadhillite present in Dr. Jaggar's specimens from the Quartette Gold Mine was so small as to preclude the possibility of obtaining sufficient material for chemical analysis or for physical investigation. The hope that more material would be found suitable for such studies has not, however, been fulfilled after the lapse of two years or more.

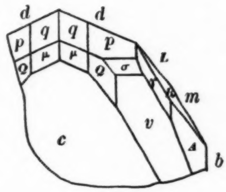
The table of angles (Table V), calculated according to Goldschmidt (Winkeltabellen, 1897, p. 19 a) for the new axial ratio derived from the Utah crystals and here adopted, includes all the observed forms of leadhillite, which are also shown in the gnomonic projection (Plate 3).



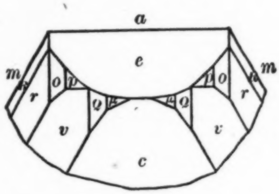
1



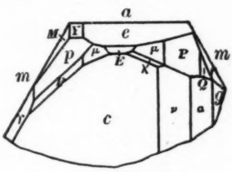
2



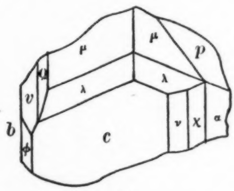
4



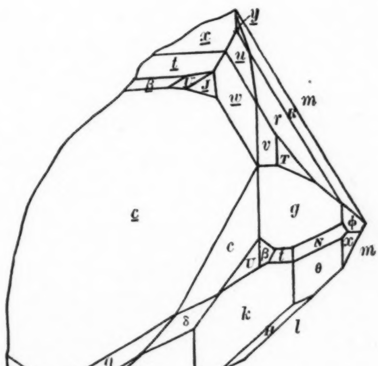
3



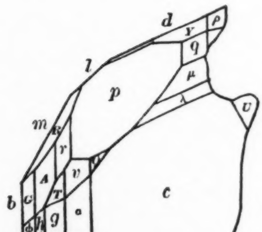
6



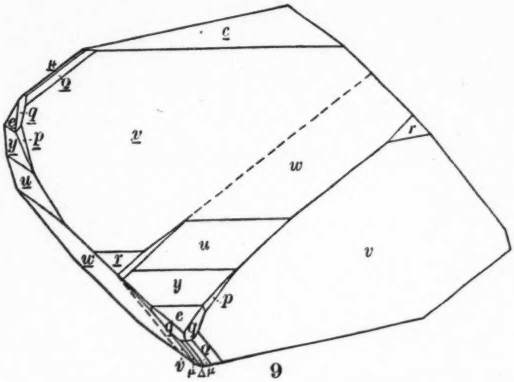
5



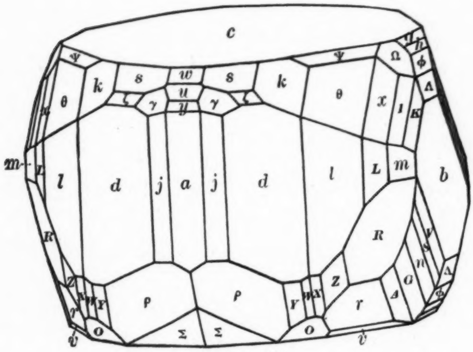
8



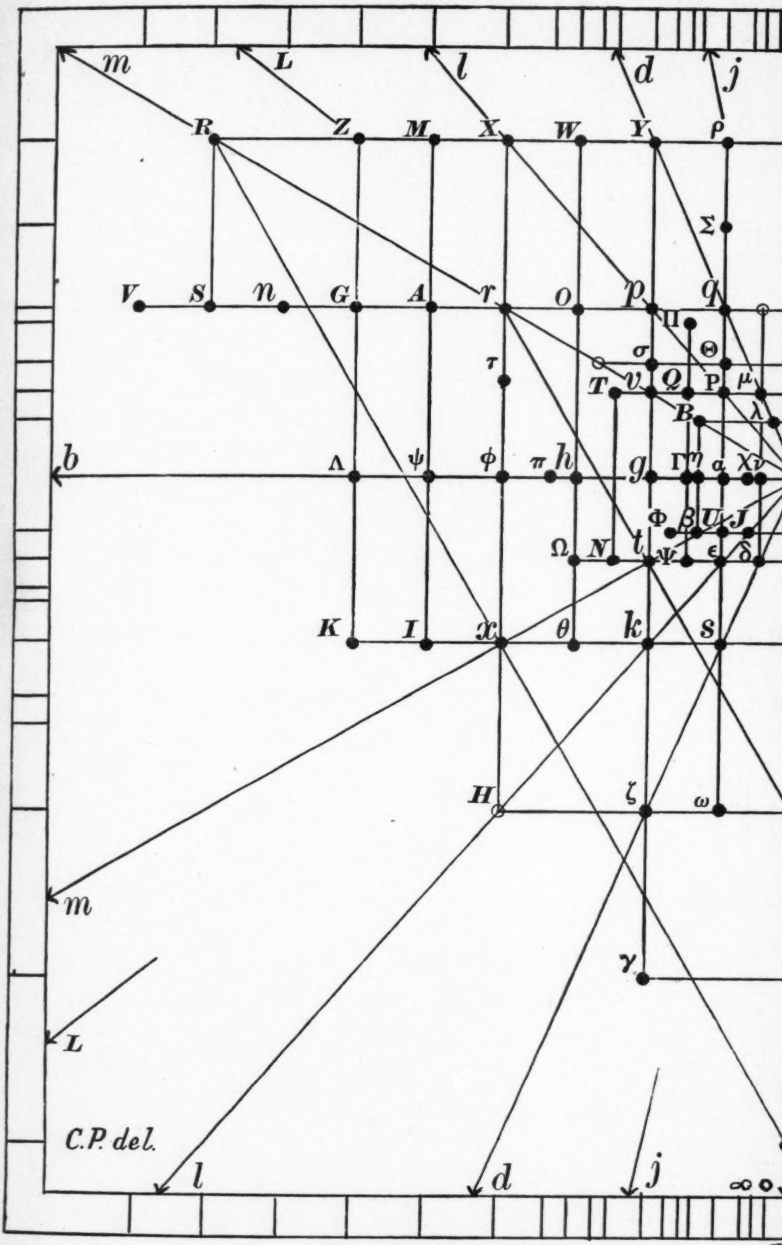
L. La F. del 7



9



10


m L l d j
R Z M X W Y ρ
Σ
V S n G A r O p q
Π
σ Θ
τ
T v Q P μ
B λ
b Λ ψ φ π h g Γ η α χ ν
Φ β U J
Ω N t Ψ ϵ δ
K I x θ k s
H ζ ω
m
γ
L
C.P. del.
l d j